

Solar Process Cold & Solar Driven Cold Rooms –

Results from the SOLERA EU project

Current Activities in the AgroKühl project

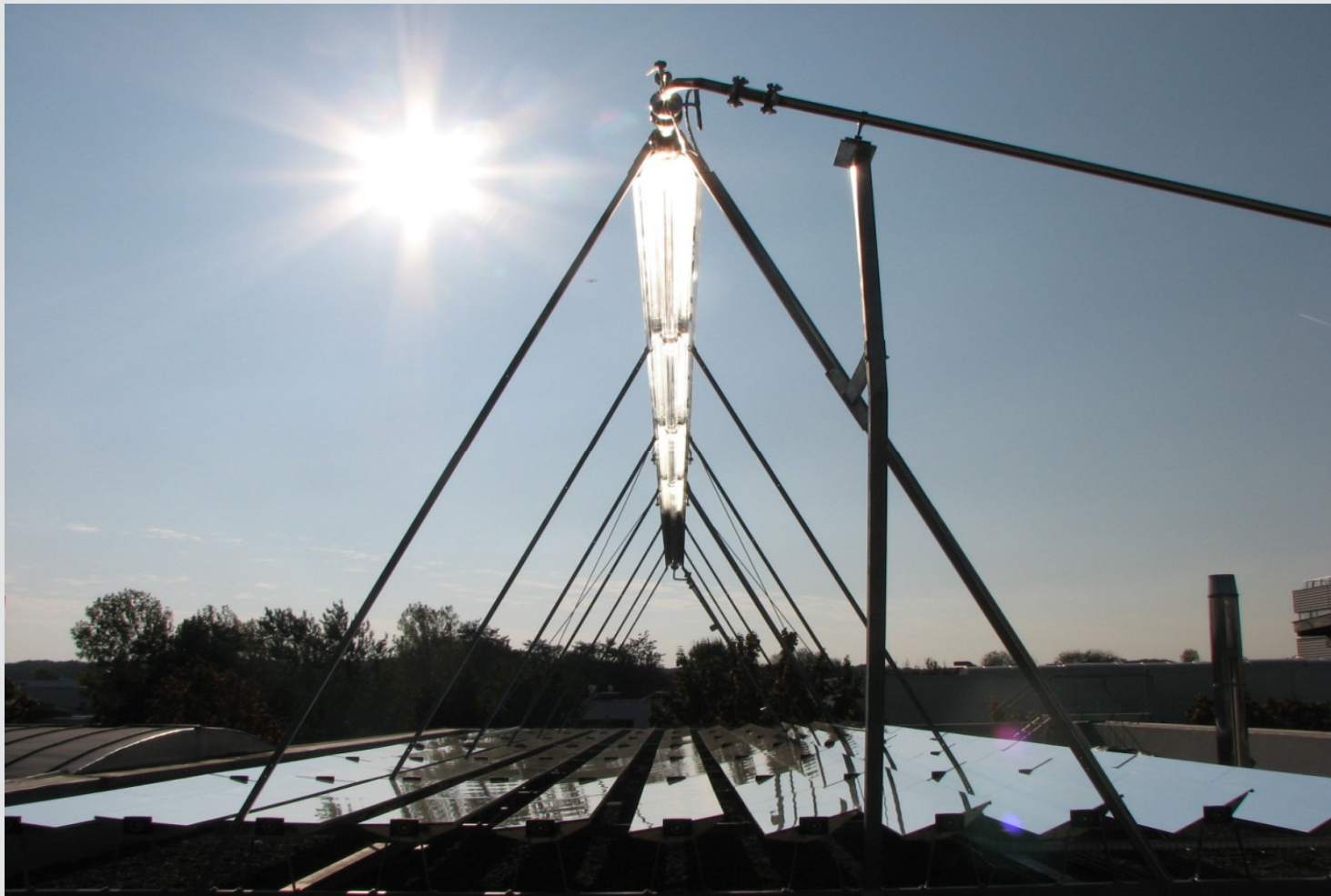
Michael Berger, 10th July, 2012
San Francisco / USA

Two similar projects

- **Recent: Solera EU project with PSE AG/Industrial Solar GmbH**
 - Demonstration of solar thermal driven cooling in three different systems
 - One of them in Freiburg with a linear Fresnel collector by Industrial Solar
 - **Goals of the system in Freiburg:**
 - cooling temperatures below 0 °C
 - dry heat rejection
 - latent heat storage (ice storage)
 - cascaded operation of smaller chillers
 - **Application:**
 - no real application
 - with electrical heaters any pre-defined load profile can be simulated and tested
 - **Project was finished in late 2011**
- **Current: AgroKühl project**
 - **Application: solar driven cold room**
 - **Industrial Solar as collector supplier**
 - **System setup is similar to Solera system, but smaller**
 - **Installation started in March 2012, Commissioning took place last week**

Recent Project Linear Fresnel Collector

INDUSTRIAL SOLAR
thermal solutions



Source: Industrial Solar GmbH

Recent Project Technical Details

- **132 m² Linear Fresnel Collector was built in Freiburg in 2009**
- **Hybrid System: Operation both possible with pressurised water or in direct steam generation**
- **Operation pressures up to 16 bar, temperatures up to 200 °C**
- **Necessary extension of existing plant:**
 - 2 Robur chillers, heat exchanger, electrical load and ice storages
 - planned November 2010, installed in early 2011, commissioned June 2011
- **Operation and Monitoring since July 2011**

Recent Project Technical Details

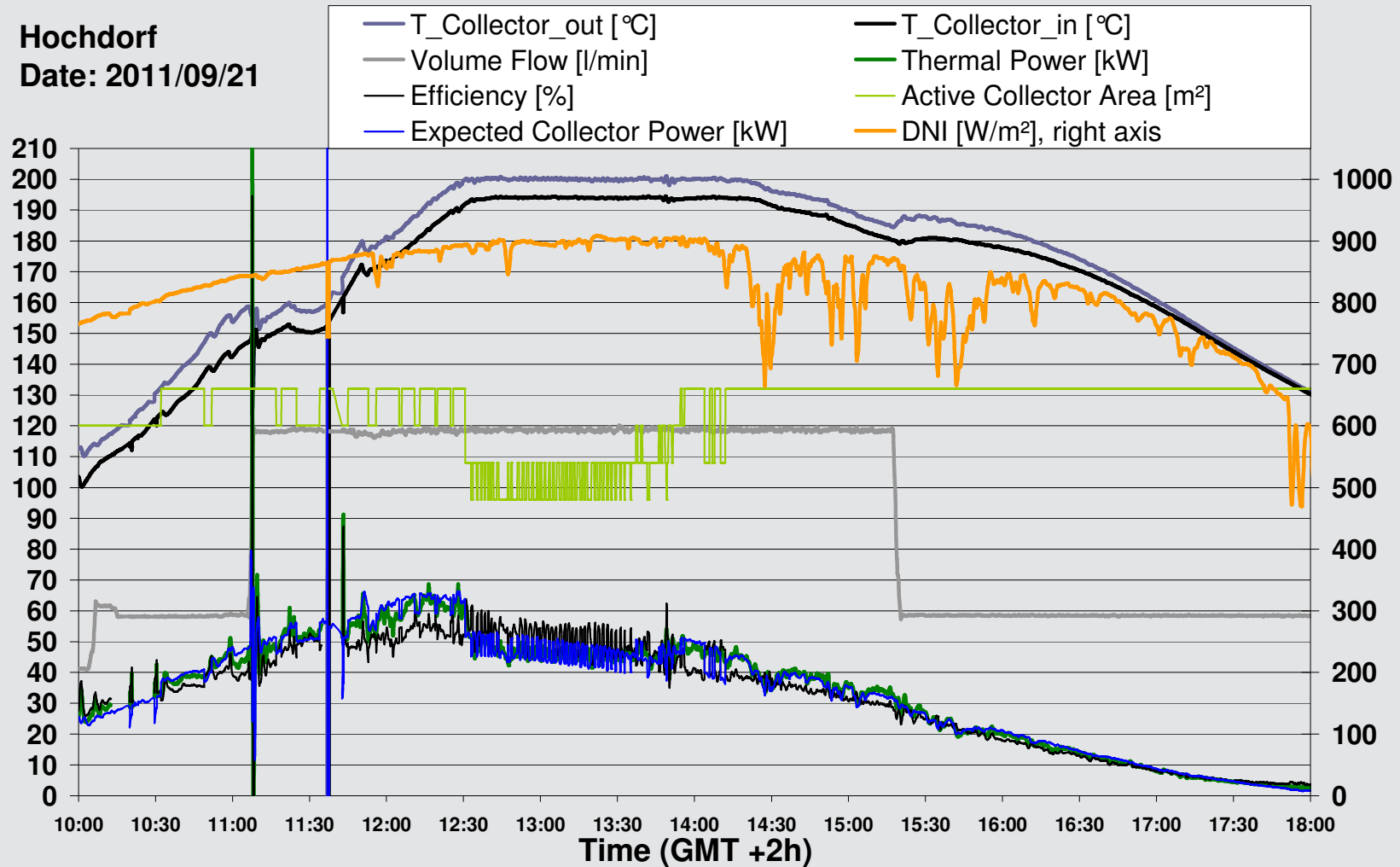
- **2 Robur water-ammonia chillers**
total cooling power of 24 kW (rated COP_{th} of 0.6)
- **Four Consolar Ice storages**
total latent heat capacity of 111 kWh (4 x 300 l of water)
- **Electric heaters as simulated loads**
total heating power of 0 .. 30 kW
- **Heat exchanger for steam operation** (2.8 m² heat exchanging area)
- **Steam drum for steam separation** (250 l, lamellar separator)

Pressurised water mode: Test Plan

- **Keeping provided temperature at chillers constant: different temperature levels (e.g. 160 °C, 200 °C), control of active collector area**
- **Collector always with maximum power (all mirrors out or all mirrors in)**
- **Cooling curve over night (test of heat losses, test of vacua)**
- **Compare operation of both chillers with cascaded operation (part load behaviour)**
- **Control variable: Temperature at collector exit**
- **Actuating variable: Active collector area**

Monitoring Results – Pressurised Water

Hochdorf
Date: 2011/09/21

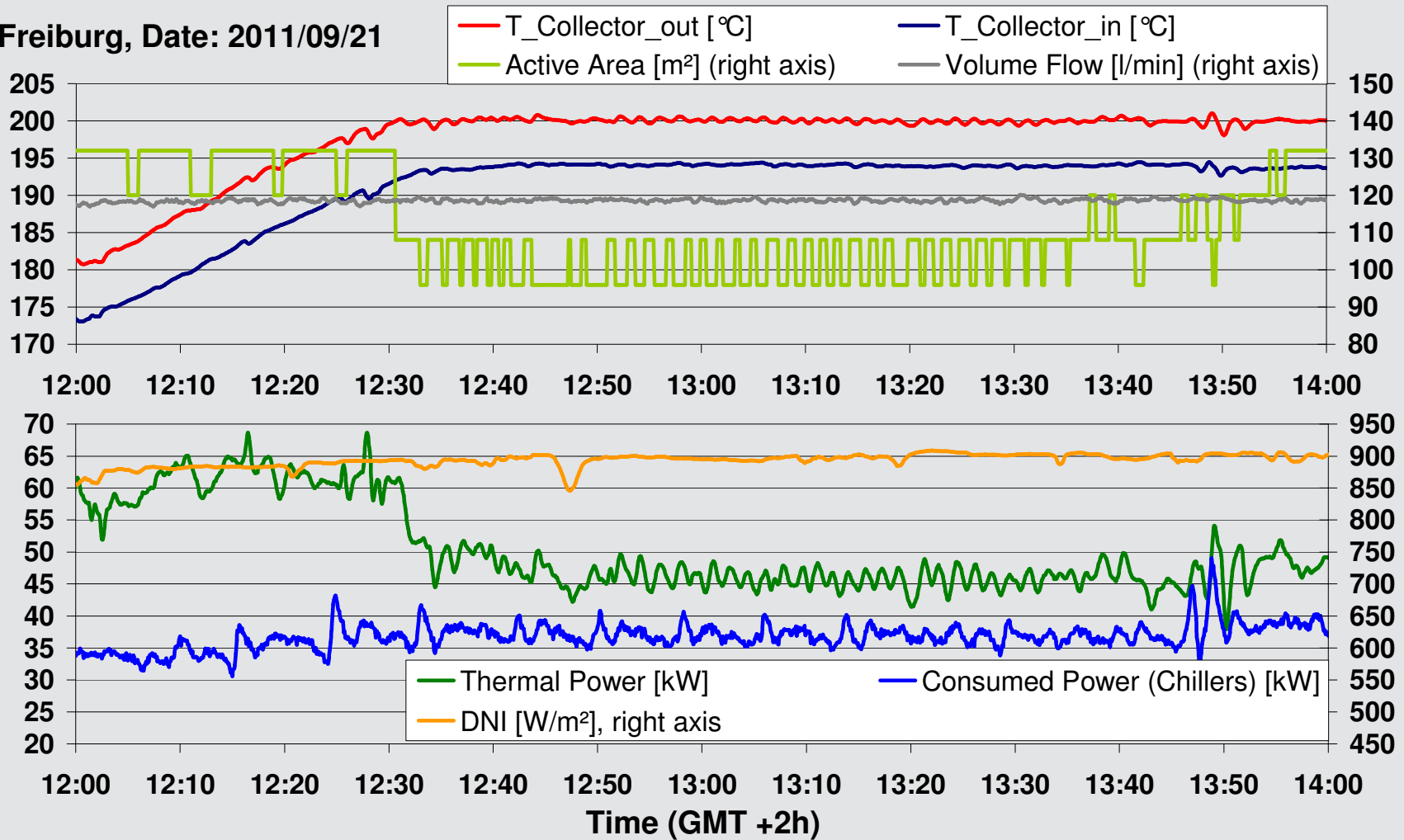


Source: Industrial Solar GmbH

Monitoring Results – Pressurised Water



Freiburg, Date: 2011/09/21

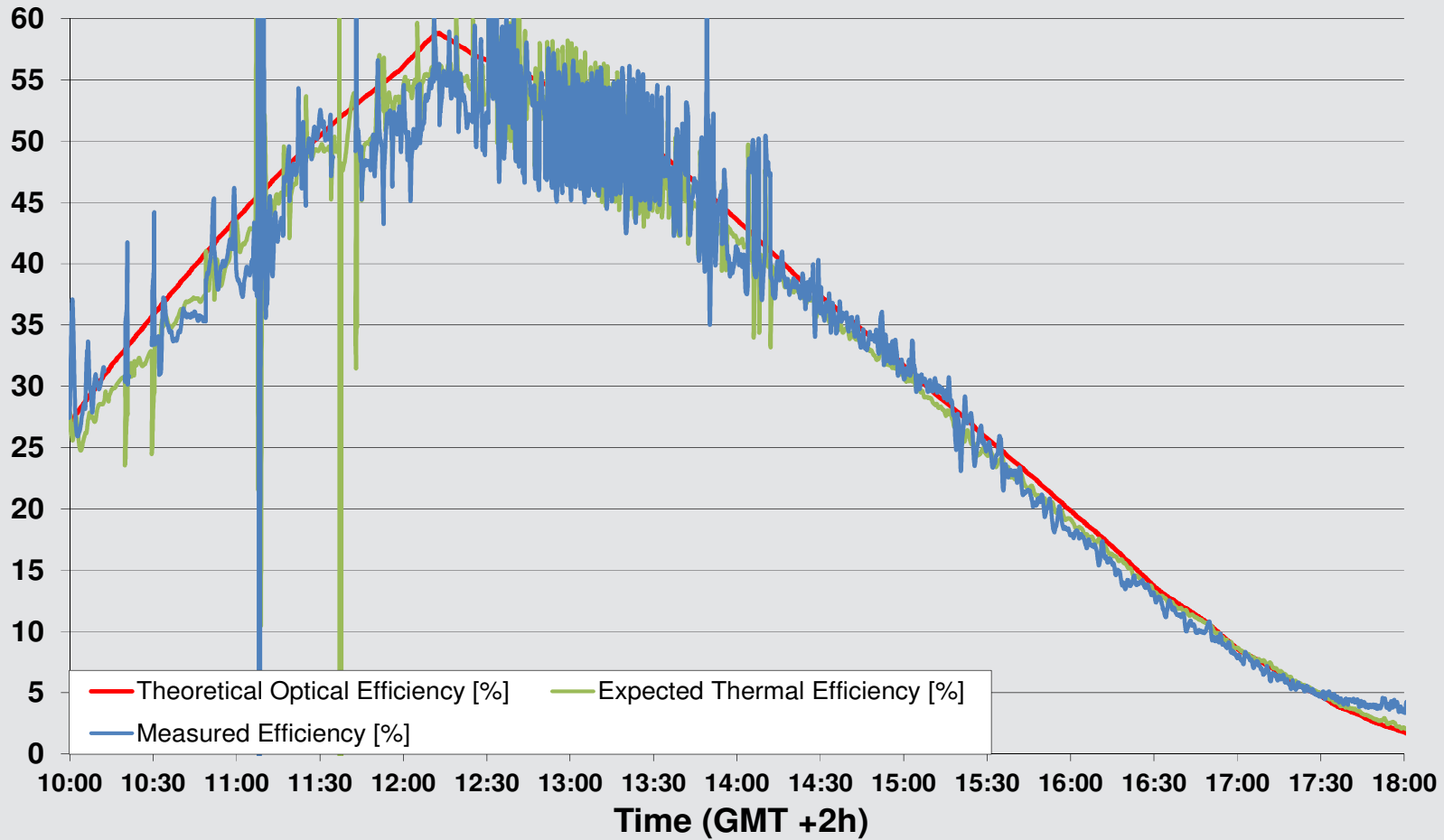


Source: Industrial Solar GmbH



Monitoring Results – Pressurised Water

SOLERA Subgroup 1, Date: 2011/09/21



Source: Industrial Solar GmbH

Summary and Lessons Learnt

- **Collector Power and Efficiency could be measured in Pressurised water operation, results matched expectations**
- **Ice Storages worked well, but heat exchanger properties could be optimised, conclusion may be:**
 - **Use larger storage only beyond certain charge level, which would have to be defined by economical optimization**
- **Chillers showed better part load behaviour in cascaded operation as expected**

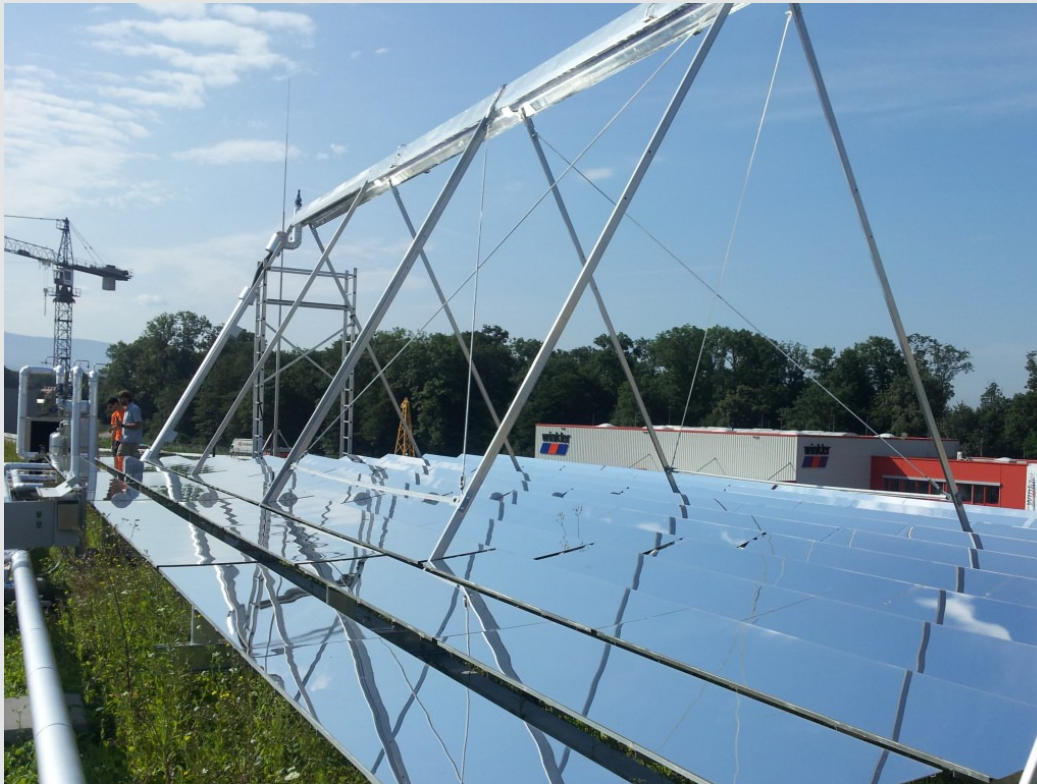
Current Project: The Cold Room



Source: Kramer GmbH

- **Manufacturer:**
Kramer GmbH
- **Area:** 32 m²
- **Air Volume:** 100 m³
- **Walls:** 120mm
Polyurethane
Sandwich
- **Steel Support
Structure
completely outside**

Current Project: The Collector



Source: Industrial Solar GmbH

- **Manufacturer:**
Industrial Solar GmbH
- **Type:** Linear Fresnel
- **Size:** 88 m² aperture area
- **Location:** rooftop of Kramer's office building
- **Operation with pressurised water:** 13 bar_g ; 180 °C

Current Project: The System

- **Chiller:**
 - Manufacturer: Robur Spa (Italy)
 - Type: Single-Effect Water-Ammonia
 - 12 kW cooling capacity
 - Rated COP 0.6
 - Dry heat rejection integrated
- **Storage:**
 - Manufacturer: Consolar (Germany)
 - Type: Ice storage (PCM)
 - 2 x 300 l water as latent heat storage
 - 55 kWh latent heat capacity
- **Commissioning: 5th/6th July, 2012**
- **Operation and Monitoring within AgroKühl project in 2012+2013.**

Thank you for your attention!

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Source: Industrial Solar GmbH

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